- A discussion of the guidelines for the development of fatigue-resistant worker schedules and fatigue pitfalls to avoid. This element provides a procedure for analyzing schedules for fatigue potential and developing alternatives.

- Suggestions regarding alternatives to long spreads and split shifts.

Developing Fatigue–Resistant Schedules

This tool provides a process for developing work schedules that are designed to minimize the risk of fatiguing the operator. The process consists of three stages: preparation, schedule analysis and redesign. This tool is designed for use by the person responsible for developing work schedules. If you organize your operator's work on a weekly basis, then you can use this tool. Alternatively, if you organize your operator's work on a daily basis and allow each operator to bid on a week's work by choosing individual runs for each day, then this tool is not appropriate for your organization.

Procedures for Developing Fatigue–Resistant Schedules

Creating work schedules based on established principles (such as the Bulletin of European Studies on Time schedules known as "BEST" guidelines) is the single most effective way the organization can minimize risk of fatigued workers. Your operators arrange their other life activities – and sleep – around their work schedules. Should their work schedule require them to work nights, for example, they are likely to sleep less given the nature of human sleep and the inherent difficulty with daytime sleep. In addition, people like to spend time with their families and friends and therefore may sacrifice their sleep time to fulfill social needs and obligations. While it is prudent to train the operators on how to organize their off-time to obtain enough sleep, you should also try to evaluate and, if necessary, rework their work schedules to minimize the chances of having a sleepy operator report for duty.

Given that the agency needs to provide service during times when most people would be asleep or with family, it is impossible to totally eliminate schedules that might lead to a sleep debt. Rather, it is important that you understand how the components of the work schedules you generate can contribute to fatigue and, to whatever extent possible, minimize these components. This section provides two tools to assist you in evaluating your operator's work schedules. In addition, reference is made to

current and forthcoming software that might help you in this endeavor.

The first tool will help you visualize the work schedule characteristics that are of greatest significance with respect to fatigue. Once you can see the schedule features of importance, you can use the second tool to interpret how to improve the schedule. This is a process that you will need to conduct each time service changes necessitate new runs and operator schedules. If you use scheduling software to generate your runs, you should try to adapt the concepts presented here to your scheduling program. You should be able to generate the graphical displays described below as well as enter rules into the schedule generator module to minimize potentially fatiguing aspects in your work schedules.

Preparation

Prior to beginning the work schedule evaluation process, you will need to do the following:

1. *Explore functionality of your scheduling software.* Determine if scheduling software provides for the inclusion of additional scheduling constraints. Also, determine whether or not it can perform staffing and scheduling analyses. You should also be familiar with the types of graphs and reports that your software provides. If your current software version does not have these features, find out if there is an upgrade available.

2. *Perform a staffing analysis and inventory.* You need to know the optimal number of people you should have on your rosters as well as the actual number. In addition it is important to know how you are currently distributing your overtime work. Determine the average amount of planned and unplanned overtime your operators receive. Determine if the overtime is shared evenly across your operators or if it is concentrated within a certain subgroup (e.g., people with more seniority). Assembling this information will allow you to determine the factors that contribute to fluctuations in operator schedules and, hopefully, to rework the schedules to avoid this uncertainty.

3. *Obtain baseline information on the level of sleepiness of the operators following current schedules.* It is likely that the person responsible for the property's fatigue management

program has already collected this information. Ask that person to forward the pertinent information to you and review it before you begin analyzing your schedules.

If information has not yet been collected, make sure the following items are included in a forthcoming survey effort:

- *Age* – Older operators have greater difficulty adjusting to rotating shift work as well as working late nights. You want to determine if these types of schedules will affect a significant portion of your operator population and if so, look for ways to minimize the number of schedules that consist of multiple late nights.
- *Job Tenure* – High workload runs are obviously more challenging to new hires than more experienced operators. Combining these runs with early morning starts or late night completion is not desirable. If you have a large number of operators with limited experience, you probably want to minimize the number of difficult assignments such as longer runs or split shifts that combine an early morning or a late night with rush hour traffic.
- *Family Status* - Operators with younger children at home are likely to need to plan their home time with some precision in order to pick up the children from school, participate in family activities, and meet other family obligations. Having overtime work suddenly presented to them could be a hardship or mean that the time they have to spend with the family at home will compromise their sleep time. Try to schedule as much of the work time, even overtime, as possible, so the operators can plan their home time accordingly to get enough sleep.
- *Alertness Assessment* – The best way to determine the impact of your scheduling is by gathering information on the level of alertness in your workforce. This may be done informally by talking with workers or union representatives about their qualitative impressions of worker alertness. If feasible, you can collect anonymous quantitative information on worker alertness by having your operators use the Sleep Debt Index. This tool will give you data for tracking fatigue management progress, with scheduling being one of the largest components. A large initial sleepiness score indicates that more aggressive scheduling changes are probably in order.

Figure 18 provides a flowchart of the procedure to use in preparing for schedule analysis.

Use Table 9 as a checklist and worksheet to collect the necessary information prior to beginning your schedule evaluation. If you find that your scheduling software does not provide many of the functions listed, you may want to inquire about software upgrades or consider purchasing a new package. Alternately, you may want to obtain a copy of the U.S. Department of Transportation schedule evaluation software, which is free and will provide you with graphs and schedule analysis and evaluation tools. (See Appendix B.)

There are different ways of calculating staffing needs. If you have not performed a staffing analysis, you might want to consider doing so as the number of employees you have available does directly affect the types and ergonomic quality of work schedules you have available to you. One straightforward formula for estimating the overall staffing level is

$$\frac{\text{Weekly platform hours}}{\text{Average weekly employee-hours available to work}}$$

where average weekly employee-hours available to work equals normal work week hours minus benefit and other hours away from work.

Lastly, understanding your workforce and their degree of potential alertness problems will provide you with guidance as to how much latitude you have in creating work schedules and what potential problem areas to address.

Work Schedule Visualization and Analysis

The next step is to prepare the nominal work schedules for analysis using a graphical depiction. Nominal work schedules are the schedules that you developed and bid, not the actual schedules worked by your operators. It is useful to graph only different schedules, that is, if two different runs operate on the same schedule, only plot one schedule. Furthermore, if you have a number of similar schedules offset by 10 or 15 minutes, only plot the schedule hourly. If you have many work schedules and your scheduling software does not produce the type of graph described below, then choose those schedules that:

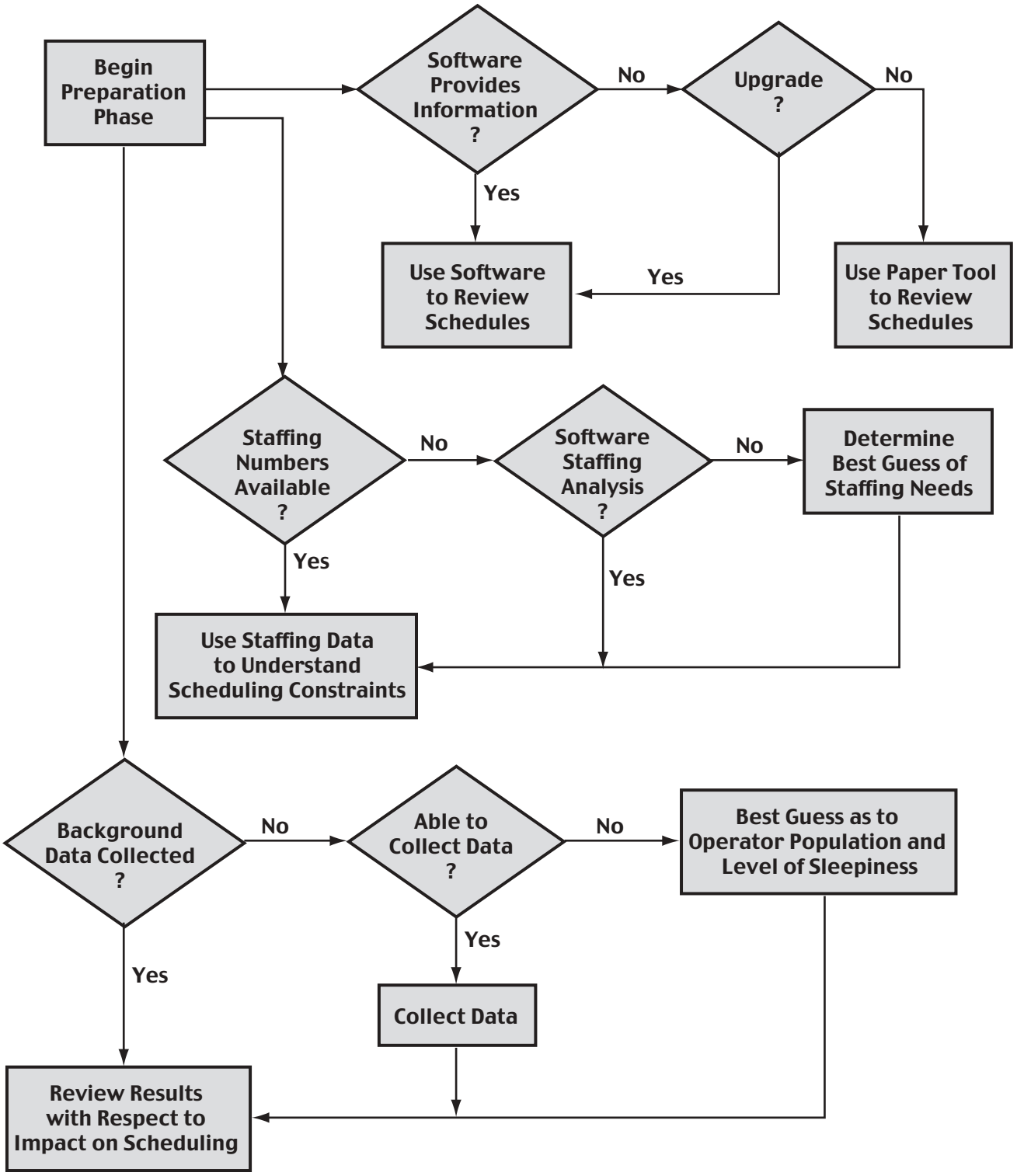


Figure 18. Preparing for schedule analysis

Table 9. Schedule evaluation checklist

Scheduling software able to: (check if available)

_____ Add fatigue-related scheduling constraints
_____ Create graphs
_____ Perform staffing analysis
_____ Perform schedule analysis

Staffing analysis results (enter values)

Estimate of required number of operators _____
Current number of operators _____
Planned overtime for schedule period (hr/wk) _____

Work force information (check if available)

_____ Age distribution
_____ Tenure distribution
_____ Family status
_____ Alertness assessment (Sleep Debt Index)

- Are most commonly worked by the subpopulations identified during the preparation step.
- Are longer than 9 hours.
- Overlap the late night/early morning hours.

Once you have collected the appropriate nominal work schedules, it is time to begin generating the graphs. If you are using your own software to generate these plots then follow its instructions for data entry and plot output. If not, you can use the template in Figure 19. In most cases you will only need to plot one schedule week unless you use a two- (or more) week schedule cycle. In those cases where the cycle extends beyond 1 week, plot out the entire cycle.

Schedule Name/Number _____

Days Off	Day	6am	7am	8am	9am	10am	11am	Noon	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm	Mid	1am	2am	3am	4am	5am	Day
	Su																									M
	M																									T
	T																									W
	W																									Th
	Th																									F
	F																									S
	S																									Su

Figure 19. Schedule analysis template

This graph has time plotted on the horizontal axis and day of the week on the vertical axis. The plot templates provided start at 6 a.m. day 1 and continue on until 5:59 a.m. on day 2 (e.g., 6 a.m. Sunday to 5:59 a.m. Monday). Plotting your schedules in this fashion allows you to see the schedule features that have the greatest likelihood of leading to alertness conflicts in transit schedules. These features include:

- Undesirable shift start times.
- Variability from day to day in start time.
- Use of split shifts.
- Long shifts.
- Interference with typical social and family periods.
- Variability in shift length.

If using the template, shade in the cells that match the hours indicated on the nominal schedule. A dark line on the midnight hour separates day 1 from day 2. Given that these plots are in hour increments, if the schedule requires 15 or more minutes of work within the hour, fill the plot cell. Place Xs in the left-hand column to indicate scheduled days off.

As an example, the work schedule in Table 10 is depicted in Figure 20.

Once you have started plotting the work schedules you will begin to see reoccurring patterns. Examine each schedule with regard to the criteria in Table 11. Enter your assessment for each schedule with regard to each criterion in the worksheet (Figure 21).

Table 10. Sample work schedule

	Work Period	
Day	Start	End
Sunday	9 a.m.	8:30 p.m.
Monday	11:30 a.m.	8:30 p.m.
Tuesday	11:30 a.m.	10 p.m.
Wednesday	11:30 a.m.	10 p.m.
Thursday	X	X
Friday	X	X
Saturday	11:30 a.m.	7:20 p.m.

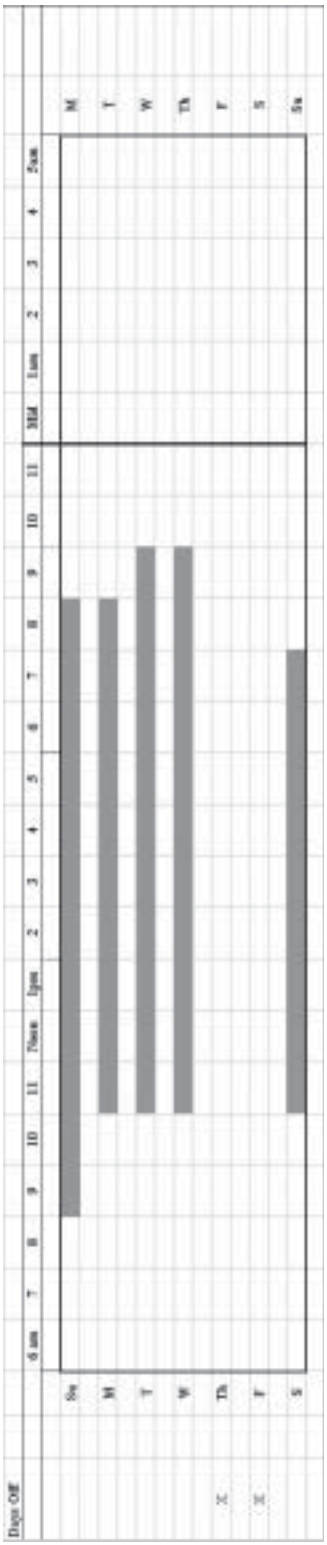


Figure 20. Sample graph

Table 11. Schedule components and undesirable and desirable values

Component	Undesirable Values	Desirable Values
Shift Start Time	1 a.m. to 6 a.m.	Other than 1 a.m. to 6 a.m.
Shift Start Variability	4 hours or more	Less than 4 hours
Use of Split Shifts	More than one sign-on per day with more than 2 hours lag	One sign-on per day, or less than 2 hours lag between sign-ons
Shift length	Greater than 9 hours	Less than 9 hours, dependent on workload of route
Social Time Interference	Job involves work during 6 p.m. to midnight or weekends	Job does not involve work during 6 p.m. to midnight or weekends
Shift Length Variability	Any shift is more than 3 hours longer/shorter than another	No shift is more than 3 hours longer/shorter than another

The Appendix to this tool illustrates common work schedule patterns found in the transit industry and explains their impact upon the worker. Pay close attention to these patterns when reviewing your schedules. Remember to take into account the needs of any at-risk workforce sub-populations that you uncovered during your preparation work.

The worksheet gives you a partial snapshot of how your current work schedules and job assignments may be affecting your workforce. To complete the picture you need an additional piece of information. Specifically, you need to determine the number of changes that occur between the nominal work schedule and the implemented schedule.

Select 30 operators with regular schedules (not extraboard) at random over the course of several weeks. Examine either payroll data or paper/electronic sign on/off records for the individual during those weeks and tabulate the number of changes made to the nominal schedule. This includes unscheduled overtime work. Add the number of weekly changes together and divide by 30 to compute the average number of unplanned schedule changes per operator that occur weekly at your property. Ideally this number should be low, indicating that you have developed regular and predictable schedules for your operators.

	Effects Operator Subgroup? (Yes/No)			Has the Following Features (Yes/No)					
Schedule No.	Age	Tenure	Family	Shift Start Time 1 a.m.–6 a.m.	Shift Start Variability > 4 hours	Splits > 2 hours	Shift > 9 hours	Social Time Conflict	Shift Length Variability
1									
2									
Total Yes									
% Affected									

Figure 21. Worksheet for schedule analysis results

Schedule Redesign

After carrying out the above analyses, you know the capabilities of your scheduling tools and you have an overview of the characteristics of the people for whom you are creating work schedules, including their level of sleepiness. Through your work schedule visualization efforts you also know how your work schedules stack up against desirable schedule characteristics. This is your starting point for creating new work schedule designs. Each new schedule generation episode will require you to 1) evaluate the alertness level of the operator workforce, and 2) evaluate your runs against the BEST criteria (see description below) with an eye on minimizing unplanned overtime and schedule adjustments.

If your scheduling software allows you to enter constraints, consider starting with the constraints suggested in Table 11. Focus on those that specifically apply to your workforce or your scheduling issues. For example, you may want to limit the spread time of a split shift or reduce start time variability to under 4 hours. If you schedule by hand, write down the constraints in a priority order and use this list to evaluate your new schedules. This is more art than science. You are trying to balance the needs of the operation against the benefits of less fatiguing work schedules.

BEST Scheduling Practices

The European Foundation for the Improvement of Living and Working Conditions publishes the BEST (Bulletin of European Studies on Time) guidelines for work scheduling. These publications synthesize the current research and theory around work scheduling practices and present it to the general public in an easy to use format. These booklets are written and edited by the foremost authorities in this scientific area, although they are focused on application within the European Union. Table 12 summarizes the current consensus in the shift work literature and the BEST guidelines regarding the development of work schedules. Research supports each of these recommendations. Consider these recommendations when developing your work schedules, but pay closest attention to the specific issues you evaluated in the previous section.

Each of these scheduling components has implications reaching far beyond reporting time. Furthermore, they are intended as a guide rather than a checklist, with the various positive and negative aspects being weighed against what you found in the preparatory

Table 12. Work scheduling BEST practices*

1. *Minimize schedules comprised solely of permanent night shifts.* Night shifts inevitably lead to less sleep time and less refreshing sleep, both of which can lead to the buildup of a sleep debt and increased sleepiness on the job.
2. *Minimize sequences of nights* – no more than 2 to 4 nights in succession. If people are working nights, try to have them also work a couple day shifts, if possible, to avoid their obtaining a chronic sleep debt.
3. *Avoid fast double-backs* – that is, short intervals of time off between shifts. People need to perform a variety of activities between working episodes. If this time is truncated then it is likely that the operators will shorten their sleep periods to accomplish their other activities, and thereby potentially fall into a sleep debt.
4. *Plan schedules with at least one free weekend day.* Many people rely on weekends to spend time with family and to accomplish larger personal tasks. It is also a time people generally unwind and sleep later.
5. *Avoid extended work sequences* – at least 1 day off per week. People need time off to take care of their personal and social obligations. Most people, when given the choice, would probably choose to earn extra money, but this makes it more difficult for them to take care of their other activities and ultimately ends up with shortened sleep time and an increased risk of at-work sleepiness. Avoid or break this cycle by incorporating off-days into their work schedule.
6. *Fix shift length to task load* – length of duty dependent upon mental/physical demands – operators should be scheduled for fewer hours on demanding runs. People have only so many mental resources and reserves to tap before they start becoming tired and fatigued, which leads to a drop in vigilance. Try to avoid allowing your operators to become run down by limiting the length of their schedules during rush hour, special events and other difficult runs.
7. *Consider night shifts that are shorter than day or evening shifts.* People working the night shift are working in unnatural and difficult conditions. Consistent with the concept of reduced hours for high workload shifts, people working nights should not be put on extended work schedules – over 8 hours.
8. *If you rotate shifts, rotate shifts in a forward direction.* While backwards rotation leads to extended time off at the end of the workweek, it also can lead to short off times between changeovers. This should be avoided. Time off is a necessary component to good shift scheduling.
9. *If you run a 24-hour operation, delay early morning shift starts.* Shift changes between 2 and 5 a.m. make it more challenging for the person coming on duty to obtain enough restorative sleep.
10. *Keep schedules regular and predictable, including overtime.* The more predictable and regular your work schedules, the easier it will be for the operators to plan around it and obtain their necessary amount of sleep.
11. *Allow some individual flexibility* – If not already in place, create an easy but controllable mechanism for operators to change out times if they have to keep a scheduled medical appointment, etc. Employees should be encouraged to schedule their activities as much as possible instead of waiting to call off sick, thereby affecting the schedule of another operator who will have to be called in or kept on unexpectedly.
12. *Limit short-term shift changes* – Give plenty of notice when changing shift schedules and what the new schedules will be. This will give the operators time to review the changes and decide which ones are best for them to bid on.
13. *Staff appropriately; avoid relying on overtime when feasible* – Creating opportunities for employees to work 7 days a week is not advisable, as it will most likely affect their on-the-job alertness.
*Wedderburn, A. "Guidelines for Shiftworkers," *Bulletin of European Shiftwork Topics,* Dublin: European Foundation for the Improvement of Living and Working Conditions, (1991).

and analysis phases of the evaluation. For example, to minimize multiple night shifts, and to provide workers with extra time off, some schedulers use fast double-backs, allowing only 8 hours between work shifts, but this strategy can result in a fatigued operator reporting for duty on the last shift. A split shift situation is a similar concept in transit, though the dead time tends to be only several hours in duration. Is it better to go on continuous or slowly rotating nights rather than use a fast double-back? Like everything else, it depends on many other factors. These factors include the demographics of your workforce (i.e., age, tenure), local and company culture (i.e., employees wanting to spend time with family or make as much money as possible), operational policies concerns (i.e., allows employee flexibility in calling off or switching runs, inadequate staffing), and other scheduling issues (i.e., start times, overtime, use of spare board).

There has been some interest in the use of compressed workweeks. The idea is that by working three or four 12-hour days, the employee would have that many extra off days to recover. The decision to use compressed weeks should be considered cautiously, especially by transit properties, which are by nature sensitive to accidents and public safety. One potential downside of compressed workweeks is that the employee is available for additional overtime work or can take a second job, thereby defeating the potential recovery effects of a 3-day weekend. Transit companies using split shifts may consider their employees to be in a similar situation except the operators do not have the possibility for an extended off-time. This is why the duration of the split should be minimized.

It is unlikely that all schedules will meet all of the work scheduling BEST practices since the scheduling process must satisfy service requirements and collective bargaining agreements. Nonetheless, within these constraints you should look for opportunities to develop less fatiguing schedules that will also positively impact your operators' physical and mental health. Creating a work schedule requires a lot of background data on the operation and its employee population, and considerable forethought on how each of these components can affect the performance and well-being of the employee.

Once you create your new schedules, either by hand or using a scheduling tool, make sure to document what scheduling BEST practices you followed, how you prioritized them and why. Two

months after implementation you should start the process over again, beginning with collecting information on operator alertness. Over time you will become more sensitive to which BEST practices are most effective in mitigating potential sleep debt in your work schedules.

Tool Appendix

Sample Work Schedules

This appendix presents the analysis of nine different work schedules. They are derived from actual work schedules and are considered to be typical of the majority of work schedules seen in the transit industry. You can use them as guides for understanding how to examine and evaluate your own work schedules.

Each of the nine work schedules is first represented as a graph. Below each graph is a grid providing a rating for the schedule on seven fatigue-related alertness features common to transit schedules. The rating is one of the following:

- A checkmark (√) indicating that the schedule complies with the BEST guidelines for that feature.
- A minus sign (-) which means that the schedule completely fails to comply with BEST.
- A zero (0) which indicates that the schedule falls short of full compliance or is towards the outer bounds of compliance, but is not completely out of bounds.

The right-hand column provides an overall assessment of the schedule's level of risk for creating a sleep debt or reduced alertness for the operator exposed to it. This section provides an explanation of the most important positive and negative elements of each schedule with respect to fatigue management.

Much of this type of analysis is a judgment call at first until you start receiving feedback as to how your schedules affect the level of on-duty alertness of your operators. Use the information provided in this guide as a starting point for understanding your schedules. Ultimately, however, the information you collect and the feedback you receive about your schedules will provide you with the most

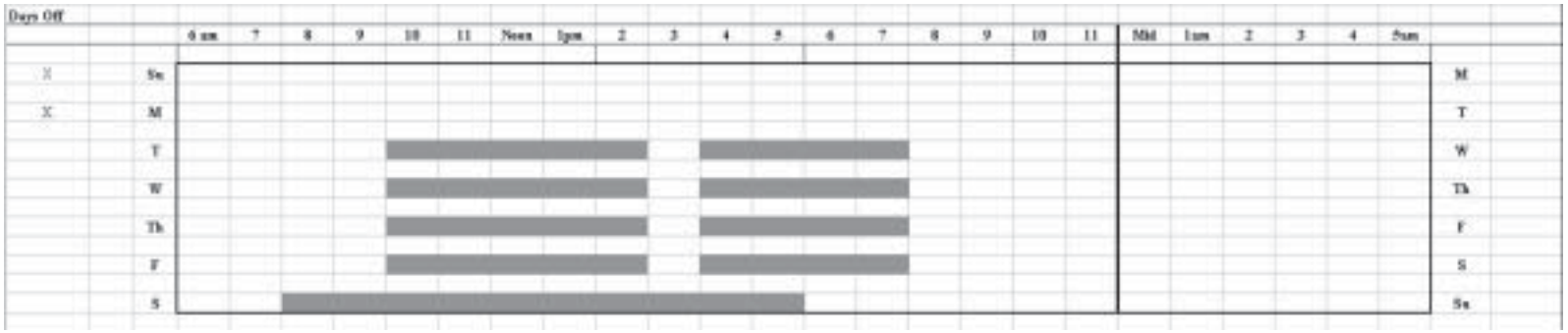
important information for understanding and improving your schedules.

The schedule in Figure 22 represents a fairly typical work time, with a delayed start time (10 a.m.) and an hour"lunch"period. Notice that the Saturday work period violates two BEST guidelines, that of working during social time (all day Saturday and Sunday) and breaking the schedule pattern and thereby adding variability in lifestyle planning. This schedule should not significantly increase on-the-job level of fatigue.

The schedule in Figure 23 includes a bit more start and end time variability than Schedule 1 and requires work on both Saturday and Sunday. In addition three of the work shifts are over 10 hours long, which may be difficult if the run is either technically challenging or very simple to perform. Given the hours of work, it is unlikely that the operator would take a second job that might further interfere with sleep or social arrangements. This schedule probably does not lead to partial sleep debt and increased feelings of fatigue at work.

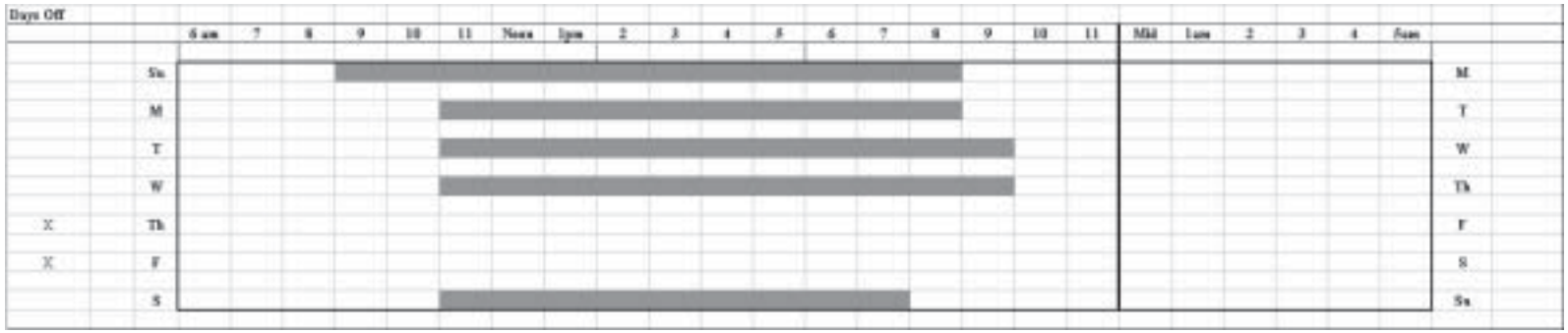
While schedule variability and weekend work are not a problem for Schedule 3, shown in Figure 24, the actual timing of the work is. Specifically, work begins between 4 and 5 a.m. and is preceded by the wake-up routine and the commute to the yard. This situation is likely to be further compounded by the operator's need or wish to spend time with family, friends or doing personal errands. The shift work literature suggests that those working this schedule would be partially sleep deprived and may be at a greater risk of a fatigue-related incident during the first few hours of duty.

These next two schedules build off of the points made for Schedule 3. Specifically, while these schedules are consistent and do not require weekend work, they have an early start time that may lead to possible sleep debt. In addition, Schedule 4 (see Figure 25) requires 12 hours of operational time with a 2+ hour split, while Schedule 5 (see Figure 26) requires less on-duty time but a much longer shift split. Obviously extended duty times can only exacerbate the problems related to diminished sleep. The splits are placed at a time when napping is easier, but it is unknown whether there are facilities available for this activity without the person having to commute home. In addition, the longer split seen in Schedule 5 provides the operator with an opportunity to take part-time or extra work, thereby eroding any



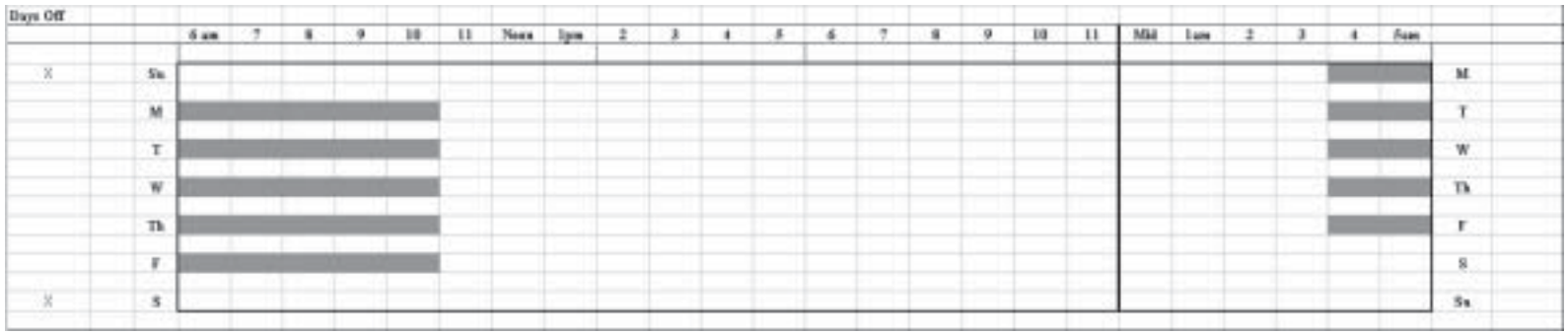
Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
√	√	0	√	-	√	√	Low

Figure 22. Schedule 1



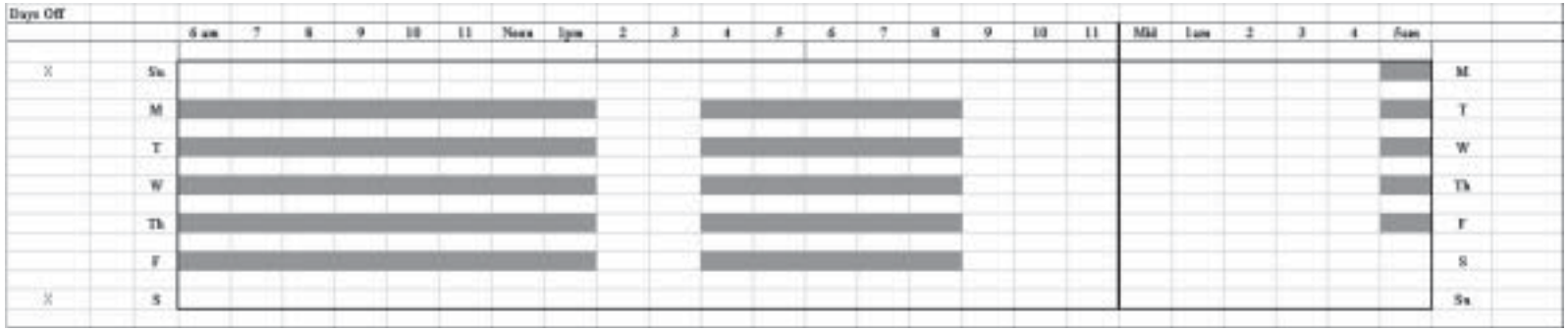
Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
√	√	0	√	-	-	0	Low

Figure 23. Schedule 2



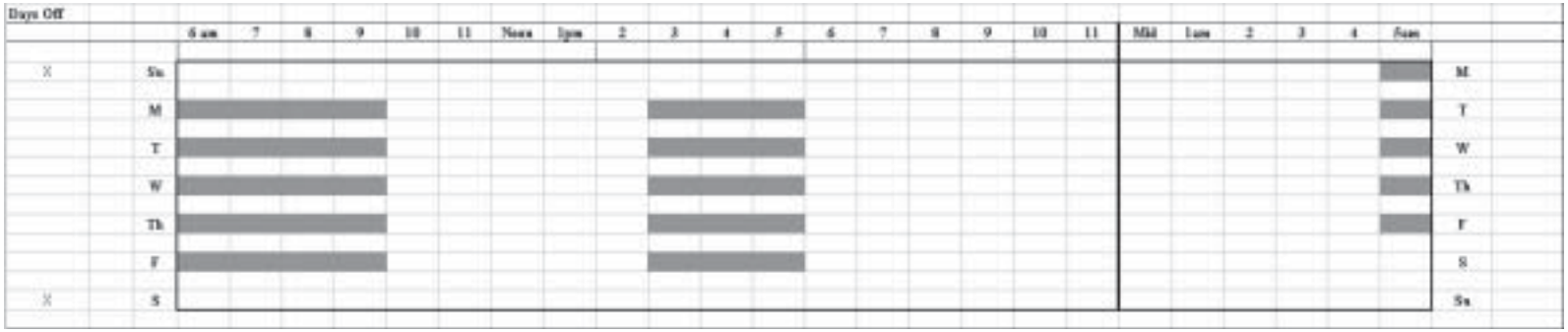
Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
–	√	√	√	√	√	√	Low/medium

Figure 24. Schedule 3



Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
0	√	√	–	–	–	√	Medium/high

Figure 25. Schedule 4



Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
0	√	√	–	√	√	√	Medium

Figure 26. Schedule 5

benefit of the"rest period." Depending on how these schedules are implemented and the individual situations of operators assigned to them, these schedules may lead to a significant increase in fatigue at both the beginning and end of the shifts.

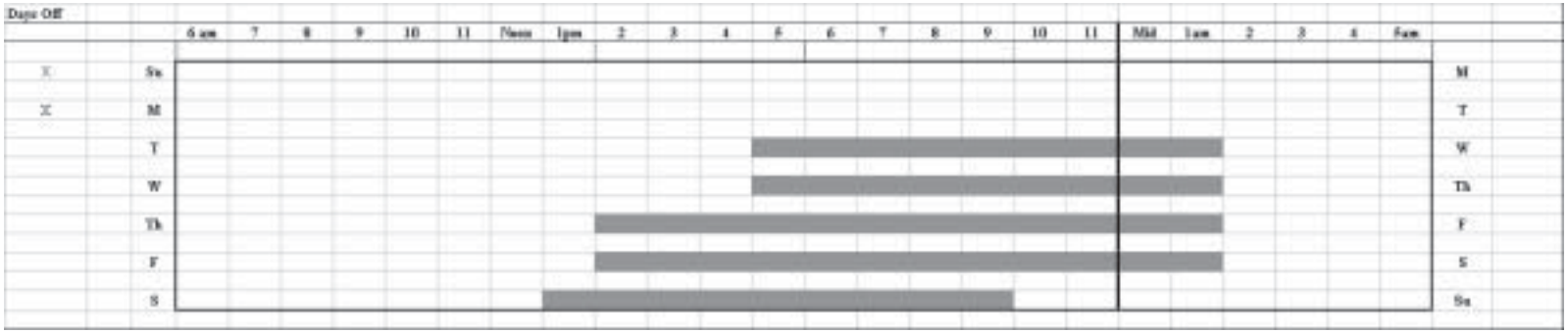
Schedules 6 and 7 (see Figures 27 and 28) both show long work episodes that end during the early morning hours and combine a time-on-task with a time-of-day effect to produce potentially significant increases in fatigue. At least one weekend day is devoted to work as well at times (i.e., 6 to 9 p.m.) that are normally dedicated to family and social activities. In addition there is great variability in work start time in a backward rotating direction that is known to lead to feelings of fatigue. These changes, especially in Schedule 7, are quite pronounced, but these work-period start times remain during the daytime and thus may not as strongly impact alertness.

Schedule 8 (see Figure 29) is an example of a highly irregular work pattern. The work start and end times, length of split and length of work period all vary from day to day. In addition, both weekend days are scheduled and two shifts occur during the early morning. This type of highly variable work schedule can easily lead to increased on-duty fatigue given the hours worked, duration of the shifts and the difficulty in planning regularity in the operator's social, family and personal life.

As a continuous operation, transit lines run around the clock and will incur work schedule issues similar to those found in industrial shift work. The schedule shown in Figure 30 has a 10-hour duration, 6 hours of which occur during the late night/early morning hours when the potential for on-the-job fatigue is at its highest. The lack of variability in the work start and end times makes the schedule easy to plan, but also provides the operator with an opportunity for taking on additional work. end T

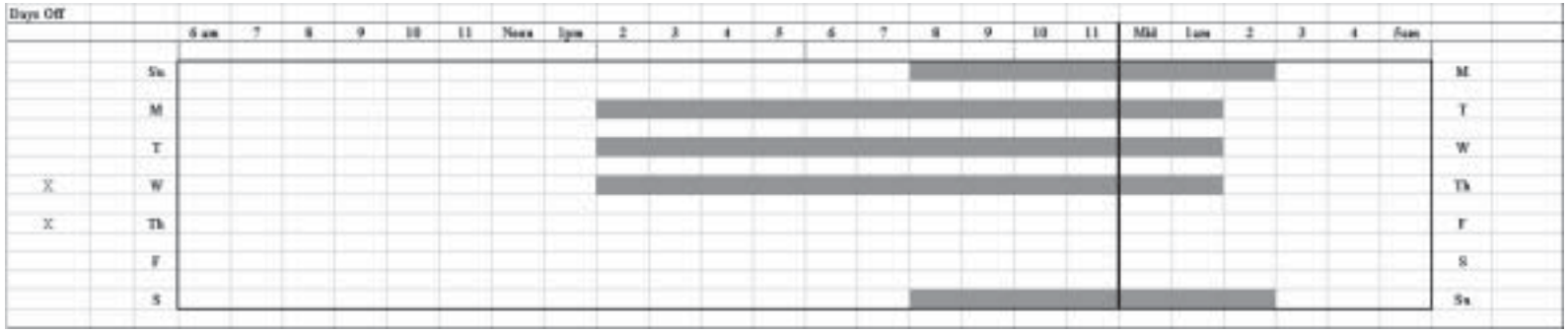
Alternatives to Long Spreads and Split Shifts

Meeting the demands of the morning and afternoon peak periods requires additional operators at these times. Traditionally full-time operators have covered the peak requirements with a daily work cycle beginning in the morning peak, followed by a midday release period and a second tour of duty in the afternoon peak. These long spread split shift days are generally both tiring for the operator and expensive for the transit agency. However, split shifts are less expensive to the agency than hiring two full-time employees with



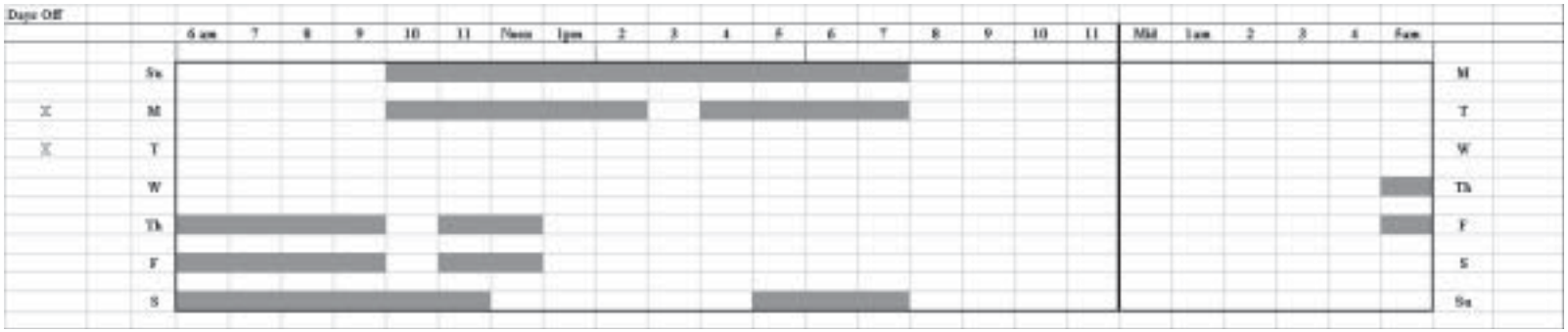
Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
√	–	–	√	–	–	0	Medium

Figure 27. Schedule 6



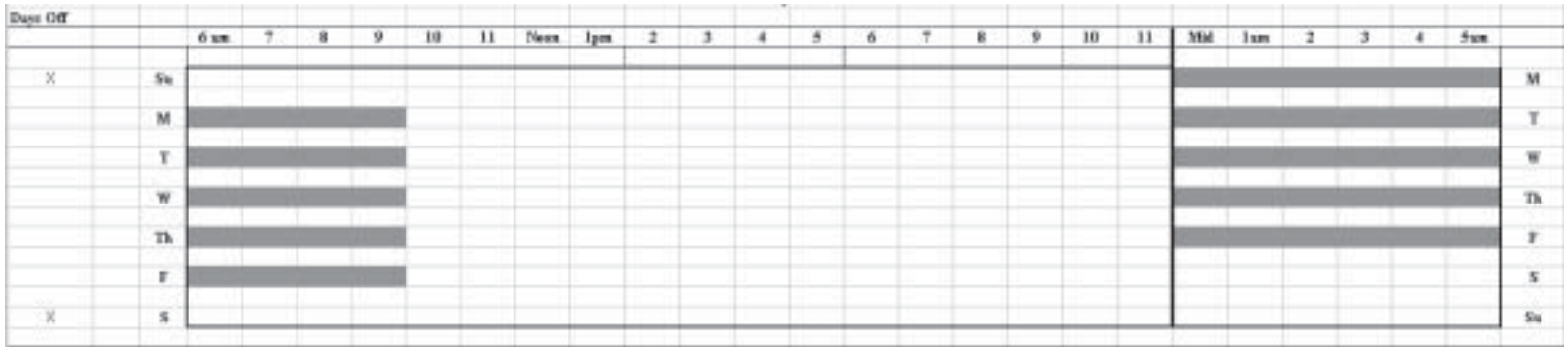
Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
√	–	–	√	–	–	–	Medium/high

Figure 28. Schedule 7



Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
0	–	–	–	–	–	–	High

Figure 29. Schedule 8



Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
–	√	√	√	√	–	√	High

Figure 30. Schedule 9

full benefits. In the last few decades, some transit agencies have hired part-time operators to provide extra service during peak periods. Some part-time operators work both peaks. Part-time operators at some agencies work only one peak period. Each arrangement has its benefits and costs to both the operator and the agency. All can potentially result in operator fatigue. The full-time operator with the long spread may benefit from premium spread pay, but the long elapsed period between departure for work and return home may compromise the individual's daily sleep period. If the part-time operator in fact wants to work full-time and s/he also works a second job, this individual may get inadequate rest leading to a compromise in on-the-job alertness. On the other hand, some individuals seek to work limited hours and the part-time position does not present the risk of fatigue related to a second job. Regardless of whether or not the driver holds a second job, the long spread for part-time operators who work both daily peaks is especially fatiguing. From a fatigue perspective, it is of interest to minimize these situations by developing innovative approaches to both scheduling and staffing.

One such innovative approach involves the use of retired drivers to meet peak service requirements. These drivers bid for peak-period part-time assignments and are allowed to work only one period per day, perhaps limited to 4 hours. The retired drivers are paid at the highest rate for an experienced driver. The transit authority generally avoids any incremental overhead cost for benefit items with this arrangement because the retired drivers are already receiving benefits from the retirement program. Depending upon the need for part-time drivers, some combination of retirees and part-timers might be employed.

Staffing an operation with both part-time and full-time operators allows the agency to minimize its pay-to-platform ratio. From an economic perspective this is desirable but in recent years the transit industry has been less than fully satisfied in its use of part-time workers. Many agencies report high turnover among part-time workers. Some find that this group is more likely to work in a fatigued state. A recent TCRP study points out that there are many individuals who seek only part-time work and recommends that agency recruitment for part-time positions focus on this group.*

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*Charles River Associates Incorporated. "Part-Time Transit Operators: The Trends and Impacts." TCRP Report 68. National Academy Press, Washington, DC, (2001).